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Informal Report

APPLICATION OF MULTITRACER TECHNOLOGY TO
PETROLEUM RESERVOIR STUDIES

QUARTERLY PROGRESS REPORT
REPORTING PERIOD: OCTOBER 1 - DECEMBER 31, 1992

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DEPARTMENT OF APPLIED SCIENCE

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OBJECTIVES

The objectives of this research program are to:

1. Improve the assessment of the character of petroleum reservoirs using tracer technology for the monitoring and improvement of EOR techniques, specifically, (a) to apply the presently available multitracers perfluorocarbon tracer (PFT) technology to the study of petroleum reservoirs in characterizing reservoir bulk subsurface flow transport and dispersion rates; and, (b) to demonstrate that PFTs with differing physical properties will interact with differing rates of adsorption and dispersion within such reservoirs, from which may be inferred difference in the character and/or extent of petroleum in those reservoirs. This is accomplished by participation in field experiments so as to fully demonstrate the perfluorocarbon tracer technology in its utility in this aspect.
2. Develop new tracers, compatible with the perfluorocarbon tracer technology, so as to interface these new tracers in a suite of tracers available for petroleum reservoir experiments. Specifically, there are two developmental objectives:
 - (a) development of an aqueous phase tracer;
 - (b) development of additional gas phase tracers.
3. Design and performance of a quantitative PFT experiment to demonstrate the potential of calculating a two-dimensional residual oil saturation map based on a multi-PFT tracer experiment in a reservoir.

SUMMARY OF TECHNICAL PROGRESS

Technical progress will be discussed according to three objectives of this program.

I. Ongoing demonstration experiments at the Naval Petroleum Reservoir in California (NPRC)

Two experiments are presently ongoing at this reservoir, the 26R experiment and the 24Z experiment. The 26R experiment has been completed with respect to injection for the first two

stages. Sampling is routinely being performed up to 10 sampling wells per week, including blank wells, i.e., wells located distances from the injectors, which will not have tracer. The samples are taken at the test separator as each sampling well is switched on for a 24 hour sampling of the hydrocarbon stream. Once the test separator is equilibrated, a sampling bomb is used to withdraw a 1 liter gas phase sample from either the low or high pressure outlet. In some instances, samples are withdrawn from both, i.e., simultaneous sampling. A range of QA/QC sampling is also being performed, that is, gas from the gas plant is being sampled. This gas plant sample represents all of the gas collected from the 26R field, some of which is reinjected in the 26R, and also the 24Z field. Thus it is necessary to sample the gas periodically.

Breakthrough of PFT appears to be occurring at several wells in the 26R field, with very low concentrations. Further sampling is needed to confirm these results.

Sampling is also continuing at the 24Z reservoir, with about 10 to 14 samples being collected per week, and forwarded to BNL for analysis. A QA/QC sampling, similar to 26R, is being collected in this reservoir also. No breakthrough has occurred to date, after approximately one year after injection.

II. Development of new tracers.

Work started in this quarter on the development of new tracers which would be compatible with the perfluorocarbon tracer technology that could be readily included with the presently available perfluorocarbons in the analytical system. This work was spurred by the discovery that a major chemical company specializing in fluorinated compounds had developed a salt of a perfluorinated compound. Closer examination revealed that this salt could possibly be chemically transformed in a perfluorinated compound readily detectable in the present analysis system. Consequently, in this quarter, an extensive search of the chemical literature was performed, and a potential chemical transformation and analysis scheme was identified. Review of this scheme indicated a reasonable chance of success for the transformation, and consequently, the necessary reagents were ordered for the laboratory experiments.

III. Design of the 2D residual oil mapping experiment

No work was performed in this quarter on this task, pending a visit in February 1993 to NPRC and UT/Austin. At that point, this experiment will be started in its design phase.

IV. Additional Activities

A report was prepared by a student collaborator on the analysis of the transport of CO₂ in the S0Z field at Elk Hills. CO₂ apparently was formed during a steam injection into the S0Z reservoir (decomposition of the carbonate rock) and unintentionally became a "tracer of opportunity". A request was made to NPRC for all of the hydrocarbon analysis of which includes CO₂ of wells surrounding these steam injectors. The analysis of the data indicated that CO₂ was transported in the reservoir as a tracer and was the existing fault system.

This report has been submitted to NPRC for their review before release, as per our agreement.

END

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